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ABSTRACT

This paper addresses the effects of the controversies involved in one state's decision to exclude the study of evolution from its science curriculum and to require equal time for creationism as an alternative theory. Curricula and textbooks are examined for the impacts of evolutionary and creationist controversies. The controversy is discussed from the historical perspective, and examples of policies in Tennessee, Kansas, Oklahoma, Illinois, Kentucky, and other states are presented. The issue is analyzed from two different levels: Level 1 analyzes the socio-cultural, political, and economic metasystems; and Level 2 analyzes the educational suprasystem. Extensive interview results from public responses to teaching evolution and creationism in schools are included. (Contains 95 references.) (YDS)

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# Creationism and Evolution: A Systems Perspective on a Textbook Controversy

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> The world itself might have been generated, rather than created, that is, it might have been gradually produced from very small beginnings, increasing by the activity of its inherent principles, rather than by a sudden evolution of the whole by the Almighty fiat. What a magnificent idea of the infinite power of THE GREAT ARCHITECT! THE CAUSE OF CAUSES! PARENT OF PARENTS! ENS ENTIUM! For if we may compare infinities, it would seem to require a greater infinity of power to cause the causes of effects, than to cause the effects themselves.
>
> — Erasmus Darwin – 1794, Vol. 1, 509 [1]

This paper is not intended to resolve the conflict between scientific and Biblical versions of human origins. Rather, its intent is to show the effect of such controversies beyond the borders of the states involved in one state's decision to exclude the study of evolution in its science curriculum and to require "equal time" for creationism as an "alternative theory." The impact of such controversies on curriculae and textbooks will be examined within a systems framework. A systems analysis reveals that causes and effects are not necessarily linearly related. Indeed, unanticipated effects of systemic actions need to be better understood by educators and legislators in their efforts at school reform as a "systemic" endeavor.

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As suggested by George B. Dyson, Professor at Western Washington State University, the words of Charles Darwin's paternal grandfather, Erasmus Darwin, in the epigraph might have been heeded as cautionary by the Kansas State Board of Education when, in August1999, it decreed that the theory of evolution be omitted from the state's science standards. Thereafter, teaching evolution in Kansas schools would be optional. In effect, it removed any incentive to cover evolution in the curriculum because the topic would not be included in the state's assessment tests. In a less publicized move, the Kansas Board also removed from its standards "a description of the Big Bang theory of cosmic origins," the central organizing principle of modern astronomy and cosmology (Glanz 1999, A1). This satisfied a group identified as "young earth creationists" who find various ways to rationalize the scientific measurement of earth's age with a literal reading of the Bible. Soon after Kansas announced its new policy, the New Mexico education board barred the teaching of creationism (Janofsky, 1999, A7). Such actions meant that mainstream publishers would have to adapt their textbooks accordingly or be left with unsold books in their warehouses. Currently, Alabama biology textbooks must carry a disclaimer that reads in part:

> This textbook discusses evolution, a controversial theory some scientists present as a scientific explanation for the origin of living things....No one was present when life first appeared on earth. Therefore, any statement about life's origins should be considered as theory, not fact. (Devlin, 1999, 25)

Oklahoma has a similar disclaimer (Henry, 2000, 11D). Such statements raise doubts about whether students exposed to them can ever have a full understanding or appreciation of the merits of evidence over opinion. At some point in their education, students need to learn the difference between "evidence" and "proof." As Keith Devlin, a British scientist who is an administrator at an American university, asked, "How can you teach science to someone who has reached 18 and thinks it is about which ideas you find the most appealing?" (ibid.)

### Scopes Redux

The creationism controversy is hardly new. It began some seventy-five years ago with the famed Scopes "monkey trial" of 1925. John T. Scopes, a biology teacher, was tried for teaching Darwinian theory. His action contravened a



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Tennessee statute that prohibited teaching theories that contradicted belief in the divine creation of Man as related in Genesis in the state's public schools. Clarence Darrow (representing Scopes) and William Jennings Bryan (representing the state) went toe-to-toe on the issue of evolution. The dramatic trial captured the public's attention. Although convicted, Scopes was later released by the state supreme court on a technicality.

Many laws proscribing the teaching of evolution remained on the books until 1968 when they were declared unconstitutional by the Supreme Court. Despite the fact that such laws were never strictly enforced, "their existence cast a pall over American education, as textbook publishers capitulated to produce 'least common denominator' versions acceptable in all states–so schoolkids in New York got short shrift because the statutes of some distant states had labeled evolution dangerous and unteachable" (Gould 2000, 28). Two decades ago, a similar textbook controversy erupted, and school districts challenged the teaching of evolution. Dena Kleiman (1980) reported that Indiana, Texas, California, Georgia and New York groups had succeeded in their efforts to persuade "parents, textbook commissions, legislators, and school officials to buy supplementary textbooks on creation or set up an equal-time policy" (A1).

In the most recent case, the American Association for the Advancement of Science (AAAS) expressed its concern about the Kansas State Board of Education's decision to remove references to evolution and cosmology from its state education standards and assessments, calling it a "disservice" to students and teachers in that state, noting that "students need to study and judge for themselves the empirical evidence and concepts central to current scientific understanding" so that they can become "informed and responsible citizens in our increasingly technological world." (AAAS Statement, October 15, 1999). The AAAS urged the restoration of the excluded topics to the state's curriculum and expressed its opposition in the strongest possible language. Summarizing his view of the matter, paleontologist Stephen Jay Gould wrote:

> The Kansas school board has reduced evolution, the central and unifying concept of the life sciences, to an optional subject within the state's biology curriculum–an educational ruling akin to stating that English will be taught but that grammar may henceforth be regarded as a peripheral frill, permitted but not mandated as a classroom subject. (28)

This paper will suggest that a systems analysis can help to disentangle the complexly intertwined issues of research, scholarship, publishing, education, and teaching–represented in this case by the suppression of a scientific theory by an educational agency and its particular impact on the school science curriculum and the publishing of science textbooks. It continues a line of inquiry presented previously at AERA (1982, 1984, 1987, 1994, 1996).

## Systems Thinking: A Paradigm Shift in Education

Such "big ideas" as explanatory theories of the origins of the universe or the origins of human life need to be seen in the broadest possible perspective. Biologist Ludwig von Bertalanffy (1962; 1968) laid the groundwork for a general systems theory (GST). His intent was to discern relationships among phenomena that had previously been seen as unrelated. C. West Churchman (engaged in research sponsored by NASA) set out the fundamental concepts of systems thinking; i.e., that a system is a set of parts coordinated to achieve a set of goals (1968, 29). Systems thinking requires an expanded approach to problem-solving that requires one to define (for the purpose at hand), the whole system, the objective(s) or purposes that set it apart from or connect it to other systems, the environment in which the system operates, and how the parts (identified as subsystems) work together to achieve its goal(s). If any part of the system fails, the whole system is at risk. Wilden (1972, 1980) utilized systems concepts to bring together disparate concepts in the social and human sciences.

The shift in perspective from a cause: effect paradigm to a systems paradigm has gained currency in the human and natural sciences. Sociologists, especially, focused on the concept, which has evolved over the years (Parsons 1951; Merton 1957; Luhmann 1995) and has recently attracted the attention of political theorist Robert Jervis (1997). Altmann and Koch (1998) preface their recent volume *Systems: New Paradigms for the Human Sciences* with the comment that the concept of a system shows that "there is a point of view from which all real phenomena have something in common" (vii). Bela H. Banathy (1968) makes the value of systems thinking clear when he says:

> in the systems concept we have available a way of thinking with which we can deal with complex problems and their changing relationships. In the systems approach we have a methodology, the use of which empowers us to develop and manage complex entities. (iii-iv)

Louis Forsdale (1981) observed:

> The General System approach suggests, above all, that you cannot look at elements singly and independently with much profit. Many model-makers strive to see a whole framework, without singling out individual elements except for momentary convenience. (35)

Thus systems thinking is transdisciplinary and, while it has found its way into business and communication studies, its impact on education has been relatively slight, Despite frequent use of the technical language of systems, i.e., output, throughput, and feedback, for example, the underlying principles of inter-relatedness and inter-dependence remain unrecognized. They are basically ignored.

In 1968, A.G. Oettinger noted that "At its best...the systems approach can be used in conjunction with well developed and reliable research designs to solve problems far more satisfactorily than naked intuition" (205). Sutherland (1973) further acknowledged the utility of this approach, stating that "the general systems theorist tries to approach complex phenomena with a prior (and necessarily crude and tentative) comprehension of the entity as a whole, a comprehension which will serve the role of a flexible, empirically responsive heuristic" (40).

Although instructional technologists were among the early adopters of systems theory, systems thinking has begun, as the formation of the present SIG formed three years ago at AERA attests, to diffuse throughout the educational enterprise. Systems approaches and the potential of systems thinking for a wide range of educational applications seem not to have appealed to researchers and curriculum designers. It requires that we learn to think differently, and that we do so consistently. Nevertheless, two decades ago, Thompson (1982) proposed an application of general systems theory (GST) to the study of the textbook in the ecology of education. Based on experience as a textbook editor, author, and adopter, the problems of textbook publishing were identified as both theoretic and tacit (Thompson 1987). The problem of the "dumbing down" of textbooks was also addressed within a systems framework (1984; 1994).[2]

When confronted with a potentially incendiary issue such as the "creationism" controversy, a systems approach may help educators to maintain a degree of objectivity in the midst of heated emotional arguments.[3] It is basic in systems theory that a change in one part of the system affects other

parts of the system to a greater or lesser extent. Therefore, the decision of the Kansas Board of Education can have a pernicious but demonstrable effect on science education elsewhere in the nation.

## The First Level of Analysis: The Socio-Cultural, Political, and Economic Metasystems

A metasystem is a large and overarching system with a comprehensive goal or purpose. In the broadest possible sense, the socio-cultural metaystem is a compendium of all artifacts, events, phenomena, values, symbols, technologies, media and texts, ideals, and ideologies past and present that play a role in everyday life, including everyday life in classrooms. It represents the social memory of the human species as whole. Curriculum in general, and textbooks in particular, are expressions of that culture. The socio-cultural metasystem in the United States includes (as a value of some segments within the system) the tendency to anti-intellectualism.

The subsystems of the socio-cultural metasystem shape the worldview of a society's members. Its values and attitudes ultimately control that system's rewards and punishments.

### *The Political and Economic Metasystems*

The political and economic metasystems co-exist with the socio-cultural metasystem (Thompson, 1982).4 Within the boundaries of metasystems, other large systems are organized to advance particular interests of the metasystem. Each has its own distinctive goals and objectives. The outputs of each inputs to other systems. Political and economic system outputs enter the educational suprasystem (a subsystem of the socio-cultural system) synchronously. Educational funding, for example, is responsive to voting blocs, and voting blocs may espouse one or another position in the evolution: creationism controversy. Contributions from special interest groups can profoundly influence voting patterns in local and State elections where education issues are most frequently debated and acted upon. Politicians and business economists must be aware of changes in popular sentiment, and learn early in their careers that unless they espouse or support principles that are popular with a significant segment of society, they are doomed to failure at the polls and at the cash register.

*Distinguishing Knowledge Systems From Belief Systems*

Early on, Talcott Parsons distinguished between systems of knowledge and systems of belief (1951, 148-9). Judith Willer (1971) commented that "Simple societies by definition contain only one system of knowledge; complex societies contain more than one" (17). Early textbooks in America—such as the *New England Primer*, the *American Spelling Book*, and the *McGuffey Readers* in their many editions—routinely included Biblical excerpts. By contrast with the scientific method, the Bible-based "theory" of creationism is the product of a particular system of religious belief. It views the Bible as the ultimate authority on questions of scientific fact equated with ultimate truth. Its adherents seek the same credibility for their religious convictions as are accorded the findings of rigorous scientific inquiry. However, they do not subject their own beliefs to the same standards of argument used to object to Darwinian theory. Thus we could conclude that one side (science) represents an open system, the "other" (religious evangelism) is a closed system. Charles Krauthammer calls the Kansas decision "an important cultural indicator" (199, 120).

## The Second Level of Analysis: The Educational Suprasystem

Every educational system is a subset of a larger whole which it is intended to serve. In this case, education operates within the context of the socio-cultural metasystem. The socio-cultural metasystem provides the social and cultural elements that form the basis or foundation of a society's "common life." Co-existing political and economic systems can be differentiated. Each system pursues its own goals and establishes subsystems to achieve its ends. So long as the system's purpose is reasonably well met, the system survives. Today, the equilibrium of the socio-cultural and educational systems have been "disturbed" by inputs from religious subsystems that impact on decision-making at various levels of the political, economic, educational, and religious systems.

In February, 2000, *The New York Times* reported that a publicly financed school– the Rochester (New York) Leadership Academy— scheduled to open the following fall, intended to include creationism as a scientifically based theory in its curriculum on a par with the theory of evolution (Wyatt, 2000, B1). Some found in this announcement a transparent attempt to introduce religion to public school education.

Viewed holistically, with all its parts included within a boundary, the educational system is a subsystem of the larger socio-cultural metasystem. It can be viewed as a "suprasystem," with the stated goal of preparing members of the society for participation in its diverse interpersonal, economic, and political activities. Inputs to this system include Time, since all education is organized in time and reflects cultural valuations of Time. The school year and "class time," for example, are both constraints and opportunities for educators. The subjects of evolution and creation refer to geological and biological timespans. Scientific and religious works have many references to Time, but science and scripture measure time in different ways. For example, scientists measure Time at the rate of radioactive decay, while Time is expressed poetically and metaphorically in sacred texts.

### Knowledge Production and Distribution Systems

Every society must produce and distribute knowledge to its members. Research universities are a major site of knowledge production. They are the gatekeepers of rigorous standards of proof. They also distribute knowledge through their teaching function and disseminate knowledge through various approved channels. What knowledge "counts" and how it is disseminated become issues in the "science wars." Since the Enlightenment and the ascendancy of the scientific method, Western civilization has valued disinterested inquiry in the search for reliable knowledge. At this point language enters the discussion. That is, factual information (which may be revised or re-framed) may be contrasted with the concept of ultimate Truth, a product of faith, not impartial investigation.

Science is a product of the knowledge production system, of the cooperative, collaborative effort of investigators in many specialized academic disciplines over time. The scientific disciplines do not rely on a single, unquestioned Authority. As Thomas Kuhn (1972) made clear in *The Structure of Scientific Revolutions*, scientific paradigms change as new evidence accumulates. While it may not appear so to the layperson, developments in the sciences require re-visions of earlier knowledge and a continually improved (but never final) understanding of the natural world. The theory of evolution is an approach to human origins that seeks to connect what might otherwise be disparate and seemingly unrelated evidence. For example, the remains of a shrew-like animal weighing less than an ounce was found recently in China (Wilford, 2000, A1). Called by its discoverers "Eosimias," or "dawn monkey":

> Eosimias appears to be a transitional figure when lower primates. known as prosimians, went their separate way, developing into today's lemurs, lorises, bush babies and tarsiers, while the diverging higher primates, anthropoids. evolved into more prepossessing creatures, eventually including human beings. (ibid.)

Such discoveries challenge our imagination and our explanatory paradigms. How one "fits" such a new "find" into one's knowledge system is influenced by whether one adopts the paradigm of science or the paradigm of a religious creed. For many (including this writer), the two are not irreconcilable.

### The Significance of Feedback Loops in Systems Analysis

Feedback plays an important role in system maintenance. It represents the return (as input) to a system that originated it (as output). Feedback in this sense is either positive or negative. Positive feedback tells the system it is operating successfully, or at least satisfactorily. Negative feedback tells the system it is operating unsuccessfully or unsatisfactorily. The current embarrassment of an educational system whose reading and math scores are not equivalent to those of other developed countries is negative feedback. It is negative feedback that creates the demand for "fixes" to the system. However, it is not always clear where the system as a whole needs fixing. Sometimes we try to fix the things that aren't broken! It is only when one grasps the inter-related and inter-connected parts of the system that one can find one (or more) solutions to a problem–including an educational problem.

As evidenced by the rather lengthy (but far from exhaustive) reference list for this paper, the Kansas decision elicited a significant amount of feedback (much of it negative), generated by many smaller "satellite systems" in the educational suprasystem. We may consider here two kinds of feedback related to the subject under discussion: popular opinion and the print and electronic media as feedback.

#### *Popular Opinion as Input to the System*

In March, 2000, *The New York Times* reported the results of a national survey conducted by DYG Inc., a respected research and polling firm located in Danbury Connecticut and headed by Daniel Yankelovich. The study was funded by People for the American Way, a civil liberties group. DYG con-

ducted extensive interviews with 1,500 people from a national, representative sample. Although the survey reported that 83 percent of Americans generally supported teaching evolution in public schools, 79 percent of those responding also thought creationism had a place in the public school curriculum. Many respondents expressed the opinion that creationism should be discussed as a belief rather than a scientific theory. The survey found strong support for teaching two origin theories. Some scientists viewed this turn of events as "a quixotic effort by the public to accommodate incompatible world views" (Glanz, A1).

As reported in *USA Today*, most Americans are not opposed to discussion of both God and Darwin in public schools:

- 83% say Darwin's theory of evolution belongs in science class;
- 66% want evolution taught as science; 17% favor evolution in science class and creationism in a class such as philosophy;
- 29% want evolution taught as a "scientific theory" and creationism added as a "belief";
- 66% state a need for a national approach, rather than leaving the issue to localities. (Henry, 2000, 11D)

Clearly, such polling results affirm the need for systems thinking in resolving the issues raised.

*Electronic and Print Media Feedback*

By a chance juxtaposition in the *Times* format, the conclusion of the "creationism" story was published alongside a report from the Associated Press that a new gigantic dinosaur (as yet unnamed) had been discovered by a team of scientists working in Patagonia. on the eastern slopes of the Andes in southern South America. This dinosaur outranked my grandson's favorite, Tyrannosaurus rex, in size and apparent ferocity. The newly-discovered species was believed to have lived about 100 million years ago, and makes a startling contribution to "dinosaur diversity" because it is believed to differ from others in that its members, unlike other species, appear to have moved in packs (Associated Press, March 11, 2000).

On March 12, CNN carried a special segment dealing with the creationism controversy. While life scientists generally accept Darwin's theory, even scientifically trained professionals seek to marshal evidence against evolution. As one high school biology teacher remarked, "I have trouble teaching

something I know is not necessarily true." He said further, I believe the Bible is God's word and there aren't any mistakes in it." This teacher claimed he "skipped" the evolution unit because "there wasn't enough time to cover the material. Furthermore, he said he would not teach evolution as a "fact." While denying that he was bringing religious beliefs into the public school classroom, he felt obliged to expose his students to "holes" in the theory of evolution. He did not feel equally obliged to point out "holes" in Biblical versions of creation. The Supreme Court has ruled that creationism is a form of religion, fueling an attack on evolution in many states. Kansas is but one of many in which the education system has been pressured to eliminate evolution in favor of creationism. Illinois and Kentucky do not include the "E" word in their standards. CNN reported that a teacher, fired for teaching the "wrong" theory, was suing a school board to get his job back. This case is sure to focus public attention on the right of students to receive a secular education in the public schools of the United States. If creationism replaces science in the schools, we will have a group of science illiterates who mask their ignorance in religious conviction.

## The Significance of Parallogics in Systems Analysis

One of the outputs of the socio-cultural metasystem is a worldview. A worldview provides the frame, or guiding paradigm, for the integration of new knowledge in a system's educational system. In systems terms, different "worldviews" could be viewed as "parallogics" (Hanson 1995 ). As explained by Barbara Gail Hanson, "Parallogic captures the notion that because meaning is specific to context, systems of logic are parallel .... When two logical arguments contest, the explanation may lie in their differing reference points." In her view, recognizing an argument as "parallogical" (rather than "contra-logical") can help to explain the "degree of separation" between two systems of logic (80-81). "Parallogical" arguments can be provided to support the goals of both science and religion. Each worldview is based on a different kind of faith and supports different convictions. The worldview of science is concerned with factual knowledge, and the worldview of religion is concerned with moral, ethical, and spiritual knowledge. Each contributes to a different kind of knowledge and understanding, both of which are important to a fully informed and experienced human life. What is meaningful from a scientific perspective is not the same as what is meaningful from a religious perspective. Ideally, one worldview will reinforce the other.

## Deja Vu All Over Again

In a 1996 presentation at AERA titled "Textbooks: Sacred Cow or Sacred Trust?" the impact of the evolution/creationism controversy was discussed. Now, four years later (the time frame of a secondary school education), the issue has still not been resolved. The impact of this unresolved issue continues to threaten not just scientific literacy in a large segment of the population, but the continuing existence of the public school system as we know it. Four years ago, the late Carl Sagan summed the controversy up in a conversation with Stephen Budiansky in words that bear repeating:

> The Bible is not a scientific book, or not lately. The science in the Bible is mainly what the Jews during the Babylonian captivity got from the Babylonians 2,600 years ago. And that was the best science on the planet in 600 BC., but we've learned a lot since. If, as fundamentalists do, you take the Bible as the literal word of God, dictated to a perfect stenographer, with no room for metaphor or allegory, then you run into deep trouble because the Bible is demonstrably wrong in areas of science. But if you take it as the work of inspired humans....then there's no problem, there's no conflict. Science and religion each are in their own sphere, and they're in fact mutually supportive. (Budiansky, 1996, 78; cited in Thompson 1996, 6)

These words seem as applicable today as they were four years ago. Perhaps where logic fails, we can adopt the notion of parallogics as developed in systems theory to understand and respect the contrasting belief systems that operate in each domain of human experience.

We might well reflect on a recent observation by Lewis, Amini & Lannon (2000):

> Many people conceive of evolution as an upward staircase.... But the vertical conceptualization of evolution is fallacious. Evolution is a kaleidoscope, not a pyramid: the shapes and variety of species are constantly shifting, but there is no basis for assigning supremacy, no pinnacle toward which the system is moving. ( 30-31)

## A System Intervention: A Modest Proposal

The point of intervention in a system is not always the most "obvious," or even the first that we, as academics, may think. The "obvious" strategy might appear to be to debate the issue and seek a consensus or compromise. But there is another solution elsewhere in the system. It was in a letter from Herbert Lin, a member of the Computer Science and Telecommunications Board of the National Research Council, who called for "collective action" by the nation's colleges and universities:

> Nearly all of these institutions require at least a year of high school science for admission, and that year of science is usually biology. Biology without evolution hardly counts as science and thus does not logically fulfill any university's admissions requirements for science....the colleges and universities of the nation could make an enormously powerful statement by announcing their refusal to count as an academic subject any high school biology course taught in Kansas. In the interest of fairness, a student from Kansas should be allowed to demonstrate adequate exposure to biology's fundamental principles, perhaps through an acceptable score on a national biology achievement test. (1999, 1849)

That means, that for many of us in higher education, participation in the governance of our institutions should be taken as an opportunity to take a stand and make a statement!

## Notes

1. Cited by George B. Dyson, Letter "Darwin in Kansas," *Science* 285 (August 27, 1999).
2. My journey into systems thinking began when I chose systems analysis as the methodology for my dissertation and continued with an effort to introduce systems thinking to the home economics curriculum as well as including systems thinking as a chapter in a management unit in a secondary school textbook *Lifeplans* (1987). The systems perspective also led to forming the Ecological and Environmental Education SIG.
3. As a matter of praxis, I have been teaching a six-credit course "The Theory of Change in Community Systems" and a "Practicum in Change Agentry and Consultation" for several years. In this two-part course, students are exposed to systems thinking and expected to analyze a current educational issue or problem from a systems perspective. Since the course is offered to students in a Guidance and Counseling Graduate Program at Lehman College, the concern is the counselor as change agent. Students are encouraged to see the "big picture" when planning a change in systems that deal with urban individual or group behavior and models of organizational development. For this portion of the course, the text has been Barbara Gail Hanson's *General Systems Theory: Beginning With Wholes* (1995). To the best of my knowledge, this course is the only one in the graduate education curriculum in my institution that requires a knowledge of systems thinking. At best, students' familiarity with the systems approach is limited, but results have been encouraging. In my experience, the transdisciplinary nature of systems thinking makes it a neutral method for the analysis of the increasingly complex problems faced by contemporary educators, administrators, curriculum designers, researchers, and publishers of educational materials.
4. The beauty of a systems approach is that it is a flexible and fluid heuristic. It is designed as an explanatory model, emphasizing inter-relationships, inter-connections, and inter-dependencies. In the present case, it is used to explain a particular education problem in the broadest possible way, so that, in effect, anything that has a bearing on the problem can be accounted for.

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